

194-505-PA3-001

## **EOSDIS Core System Project**

# **Description of Contractor and Subcontractor Audit Programs for the ECS Project**

September 1994

Hughes Applied Information Systems  
Landover, Maryland

# **Description of Contractor and Subcontractor Audit Programs for the ECS Project**

**September 1994**

Prepared Under Contract NAS5-60000  
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# Preface

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This document is a formal contract deliverable with an approval code 3. It requires Government review and approval prior to acceptance and use. Changes to this document also require Government approval prior to acceptance and use. Changes to this document shall be made by document change notice (DCN) or by complete revision.

Once approved, this document shall be under ECS Project Configuration Control. Any questions or proposed changes should be addressed to:

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## Abbreviations and Acronyms

# 1. Introduction

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## 1.1 Identification

This Contractor and Subcontractor Audit Program document, Contract Data Requirements List (CDRL) item 080, whose requirements are specified in Data Item Description (DID) 505/PA3, is a required deliverable under the Earth Observing System (EOS) Data and Information System (EOSDIS) Core System (ECS), Contract (NAS5-60000).

## 1.2 Scope

This document describes the Contractor and Subcontractor Audit Programs for the ECS Project.

## 1.3 Purpose and Objectives

The purpose of this document is to define the ECS audit processes, audit reporting requirements, and areas to be audited. The objective of this plan is to provide the framework by which the ECS Quality Office will audit the effectiveness of the project's internal performance assurance system to ensure compliance with the provisions of the Performance Assurance Implementation Plan (DID 501/PA1) and the contractual requirements of the ECS project.

## 1.4 Status and Schedule

This version of the Audit Plan is submitted to the Government two weeks prior to the ECS System Design Review as an approval code 3 document. This document will be maintained and controlled by the ECS Data Management Office (DMO).

## 1.5 Document Organization

This document is organized into the following seven (7) sections.

Section 1, Introduction.	Provides the scope and purpose of this plan.
Section 2, Related Documentation.	Provides a bibliography of referenced documents for the ECS Audit Program organized by parent, applicable, and information subsections.
Section 3, Overview of ECS Project Organization.	Provides a description of the Quality Office organization and performance assurance management responsibilities.
Section 4, Audit Preparation.	Describes ECS audit planning, preparation, and responsibilities.
Section 5, Conducting Audits.	Provides the procedures for conducting audits.

Section 6, Auditable Areas.	Describes activities in each area of the Project that are subject to audit by the quality office.
Section 7, Reporting of Audit Results.	Provides both internal and Goddard Space Flight Center (GSFC) audit reporting requirements.

## 2. Related Documents

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### 2.1 Parent Documents

The following documents are the parents from which this document's scope and content are derived.

GSFC 6/2/94	Functional and Performance Requirements Specification for the Earth Observing System Data and Information System (EOSDIS) Core System
GSFC 2/16/93	EOSDIS Core System Statement of Work
GSFC 6/2/94	EOSDIS Core System Contract Data Requirements Document
GSFC 420-05-03	Earth Observing System (EOS) Performance Assurance Requirements for the EOSDIS Core System

### 2.2 Applicable Documents

The following documents are referenced herein and are directly applicable to this document. In the event of conflict between any of these documents and this document, this document shall take precedence. As the program evolves, this list will be updated.

102/MG1	ECS Configuration Management Plan
103/MG3	Configuration Management Procedures
105/MG3	ECS Data Management Procedures
202/SE1	ECS Standards and Procedures
301/DV1	Software Engineering Plan
308/DV2	Software Development Plan
424/VE1	Verification Procedures
501/PA1	Performance Assurance Implementation Plan
502/PA1	Contractor's Practices & Procedures
503/PA3	Performance Assurance Status Report
506/PA3	Audit Reports
508/PA1	Responses to Review Team Recommendations and Action Items
510/PA1	Summary Reports of Contractor Reviews

## **2.3 Information Documents**

The following documents, although not directly applicable, amplify or clarify the information presented in this document, but are not binding.

09/89	Software Assurance Guidebook, SMAP Working Group
11/90	Software Quality Assurance Audits Guidebook

## 3. Overview of ECS Project Organization

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### 3.1 ECS Project Organization

ECS is comprised of three segments defined to support three major operational areas: Flight Operations Segment (FOS), Science Data Processing Segment (SDPS), and Communications and System Management Segment (CSMS). The segments are further divided into ECS functional elements. There are a number of support organizations within ECS, such as Business Operations (BOO), Maintenance and Operations (M&O), Science, System Integration and Planning (SI&P), Configuration Management (CM) and Data Management (DM). Audits will cover activities within all organizations on the ECS Project. For purposes of a project overview, the three functional elements are described below.

#### 3.1.1 Flight Operations Segment

The Flight Operations Segment (FOS) manages and controls the EOS spacecraft and instruments. The FOS elements include the EOS Operations Center (EOC) and the Instrument Control Centers (ICCs). The EOC element is responsible for mission planning and scheduling and the control and monitoring of mission operations of the EOS spacecraft and instruments. The ICCs is responsible for scheduling, commanding, and operating the science instruments and for monitoring instrument performance.

#### 3.1.2 Science Data Processing Segment

The Science Data Processing Segment (SDPS) provides a set of processing and distribution elements for science data and a data information system for the entire EOSDIS. The SDPS consists of:

- Product Generation System (PGS) - an element which processes data from the EOS instruments to Level 1-4 data products.
- Data Archive and Distribution System (DADS) - an element which provides short and long term storage for EOS, and other Earth Observing Missions, as well as other related data, software, and results, and distributes the data to EOSDIS users.
- Information Management System (IMS) – a distributed data and information management element and user services suite for the ECS including a catalog system in support of user data selection and ordering.

#### 3.1.3 Communications and System Management Segment

The Communications and System Management Segment (CSMS) provides overall ECS management and operations of the ground system resources, provides facilities and communications/networking services for an extensive science data communications network, and manages the interfaces to National Aeronautics and Space Administration (NASA's) Space

Network (SN) and Deep Space Network (DSN), the Wallops tracking station, the EOS Communications (Ecom), the Program Support Communications Network (PSCN), and other communications networks. The CSMS elements include:

- System Management Center (SMC) – a system management service for EOSDIS ground system resources.
- EOSDIS Science Network (ESN) – a dedicated internal ECS communications network and services providing, in combination with other institutional and public networks, for the interconnection of the widely distributed EOSDIS facilities, Internet Protocols (IPs), and EOS investigators at their Instrument Support Terminals (ISTs) or Science Computing Facilities (SCFs) as required to support ECS operations; and a separate network interface from the ECS to gateways provided by the NASA Science Internet (NSI) to external science research networks in support of other science communities' access to the ECS.

### **3.2 ECS Quality Organization**

Responsibility for management of the ECS audit program resides in the Quality Office. This office independently reports to the executive office of the Hughes Applied Information Systems, Inc. (HAIS). Specific oversight of ECS has been assigned to the Executive Office of HAIS.

Each subcontractor is responsible for identifying a quality assurance representative. Collectively, these representatives and the HAIS Quality Office form the ECS Quality Team. Members of the team will be assigned to audit specific functional areas of the ECS project, with reporting requirements to the Quality Assurance (QA) Manager. The Quality Office manages these allocated tasks and ensures conformance to program procedures and contractual standards.

### **3.3 Management of the Audit Program**

During the entire ECS system life cycle, the Quality Office monitors, inspects, and audits processes to ensure that policies and procedures are followed, and that the ECS Project Team is compliant with designated standards. The Quality Office has assigned a quality representative to each segment of the ECS program described in Section 3.1. The representatives assigned to the Quality Office monitor and audit hardware, software, safety and reliability requirements of ECS and are responsible for implementing and documenting the audit requirements provided in this plan.

### **3.4 Baseline Audit**

The Quality Office will conduct a baseline audit of the ECS project. The initial baseline audit will be conducted to identify those management activities that are missing or that require improvement. Results of this audit will form the basis for performing follow up audits and creating the quality metrics required to measure performance of the ECS Project.

In-process audits will be performed to ensure that corrective actions noted during the baseline audit are being implemented and that metrics are collected to ensure that the ECS program is meeting its performance assurance requirements. GSFC will be apprised of this activity at the Bi-weekly Performance Assurance Managers Meeting. These audits will be conducted from development to release.



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## 4. Audit Preparation

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### 4.1 Audit Planning

The Quality Office is responsible for planning audit activities which verify the quality of the ECS performance assurance program. These audit activities include both in-process audits and formal program review audits. Audits encompass internal processes, standards, procedures, project instructions (PI's), review activities, and ECS hardware and software products. The auditable areas are listed in Section 6 of this plan.

#### 4.1.1 ECS Internal Processes

The Quality Office ensures management, engineering, and quality processes are documented and implemented. Management processes include requirements management, project planning, project tracking and oversight, subcontract management, QA, configuration management, and status reporting at all levels. Engineering processes include analysis, design, code, hardware integration, segment/element and system integration, and acceptance testing. Quality processes include verification, validation, and nonconformance reporting.

The Quality Office reviews the ECS management plans to understand and become familiar with the processes used to develop and control ECS products. These plans and associated milestone schedule are described in the ECS Contract Data Requirements Document (CDRD).

#### 4.1.2 Plans, Standards, Procedures, and Project Instructions

The ECS project plans, standards, procedures, and instructions are reviewed to determine level of implementation and compliance during the system development process. These documents are:

102/MG1	ECS Configuration Management Plan
103/MG3	Configuration Management Procedures
105/MG3	ECS Data Management Procedures
202/SE1	ECS Standards and Procedures
301/DV1	Software Engineering Plan
308/DV2	Software Development Plan
424/VE1	Verification Procedures
501/PA1	Performance Assurance Implementation Plan
502/PA1	Contractor's Practices & Procedures

The Quality Office has signature approval on these documents, as referenced in the Performance Assurance Implementation Plan (PAIP), and shall conduct in-process audits to determine the extent of compliance on the ECS project.

Through analysis of contract requirements, deliverable hardware, software and documentation, the Quality Office gains an understanding of the ECS objectives and products to be produced. Audits are conducted to ensure incremental life cycle verification activities are effective. The Quality Office audits hardware and software processes prior to GSFC delivery to ensure that proper testing and verification activities occurred and that all discrepancies have been documented.

#### **4.1.3 Audit Scheduling**

The Quality Office participates in all project management and technical milestone reviews. Activities from these reviews are formally reported to GSFC in Summary Reports of Contractor Reviews (DID 510/PA1) and Responses to Review Team Recommendations and Action Items (DID 508/PA1).

The Quality Office is made aware of upcoming events, associated activities, and potential risk areas through these reviews. This information shall be the basis for scheduling audits. The GSFC Performance Assurance Office is informed of planned audits through two sources: the Bi-weekly GSFC/HAIS status meeting and the Performance Assurance Status Report (DID 503/PA3).

### **4.2 Audit Preparation**

For each planned audit, a checklist is developed which describes items to be examined, questions to be asked, risk areas, and other specific areas of concern. The Quality Office reviews and analyzes on-going project status through status reports, interaction with the assigned quality representative for each area, and the results of previous audits. These activities assist the Quality Office in defining areas requiring more detailed audits than had previously been planned or more frequent follow-up activities.

The Quality Office notifies the functional manager, through a formal memo, at least two weeks in advance of a scheduled audit. The memo includes the following items:

- The intent of the audit
- Identification of the Quality Representative(s) conducting the audit
- The records to be examined
- Individuals the auditor wishes to interview

People to be interviewed may include managers, selected developers, CM staff, assurance staff, and testers. Copies of the checklists are furnished as an attachment to the memo to facilitate communications, increase understanding, and provide a cooperative effort during the audit. A copy of this memo is retained by the Quality Office for record.

### 4.3 Responsibilities

Table 4-1 describes the responsibilities of the QA Manager, and the Audit Team Leader , the Audit Team Members and the interviewee.

***Table 4-1. Audit Responsibilities***

<b>FUNCTION</b>	<b>RESPONSIBILITIES</b>
QA Manager	<ul style="list-style-type: none"><li>• Plans audits and identify special audit needs</li><li>• Assigns the audit team and select an audit team leader</li><li>• Resolves conflict areas or resource problems</li><li>• Coordinates all audit activities with the GSFC Performance Assurance Office, the ECS project management team, and functional areas affected both by the audit and the audit results</li><li>• Documents all audit results in accordance with DID 506/PA3, Audits Reports</li><li>• Schedules follow-up audits</li><li>• Conducts a Post Audit Presentation at ECS Project Management Reviews</li></ul>
Audit Team Leader	<ul style="list-style-type: none"><li>• Coordinates orientation &amp; training of team as needed</li><li>• Coordinates resources for audit (facilities, materials, documents, and tools)</li><li>• Facilitates "kick-off" and debrief meeting with audited organization</li><li>• Prepares Internal Audit Report for submission to QA Manager</li></ul>
Audit Team Members	<ul style="list-style-type: none"><li>• Develop and tailor checklists</li><li>• Conduct audit</li><li>• Document and collect information by completing checklists</li><li>• Document audit discrepancies</li></ul>
Team/Area Being Audited	<ul style="list-style-type: none"><li>• Provides objective evidence to support compliance</li><li>• Participates in kickoff and debriefing meetings as well as required interviews</li><li>• Responds to corrective action requests</li></ul>

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## 5. Conduct of Audits

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### 5.1 Audit Objectives

The purpose of an audit is to collect data to assess the quality of products and to ensure compliance with procedures. The audit is intended to uncover any significant deviation from standards, procedures, or reported status. Deviations shall be tracked so that corrective action can be taken.

### 5.2 Documentation Examination

The auditing team shall use two basic techniques: interviews with the staff members and examination of records. Before interviews are conducted, the auditing team will examine the available documents. Documentation shall include, but not be limited to, requirements and design documentation, drawings, procurement records, development folders, manuals, code, and hardware units and components, as well as the paper trail (records examination) which documents the events in the life cycle.

#### 5.2.1 Records Examination

Records are examined to determine if a procedure is correctly followed. Record examination includes, but is not limited to, CM records, Nonconformance Reporting and Corrective Action records, and Verification and Validation (V&V) records.

- CM records prove the authorization of each change, the product changed, and the version numbers of the changed product. The auditor will check to ensure that documentation is current with the changes. The CM records should demonstrate that adequate security measures are in place to prevent loss and unauthorized changes. Physical examination of the product is conducted to verify product location and traceability to change records.
- The nonconformance reporting and corrective action records ensure that changed and/or corrected products still satisfy requirements and standards. The auditor assures that reports are completely and correctly filled out. The disposition process and Configuration Change Board (CCB) action are traced to the nonconformance report. Nonconformances that resulted in product changes are traced to the product to ensure changes were made, tested, or reviewed.
- V&V records ensure that test plans, procedures, and results are documented and approved. The auditor verifies that all nonconformances observed during testing are recorded in the nonconformance system. If inspections or peer reviews are used to detect problems and errors, the auditor verifies the reviews are documented and corrected and changes are made to the product.

- Deliverable documents are measured against applicable DIDs and internal ECS documentation standards to ensure correct content and style. The auditor is not responsible for the technical content of the documents, rather, the auditor is responsible for making an assessment of the correct content and style as described in the DID and internal ECS documentation standards.
- The auditor examines software code to determine if it meets coding standards, including rules for internal documentation, size of modules, and styling formats. Rules for coding constructs or variables are audited in one of two ways. First samples of the code may be processed through a code standards checker or analyzer. Second, records from walkthroughs and/or inspections may be used to verify coding standards.

### **5.3 Conducting Audits**

A "kick-off" meeting is scheduled to provide an opportunity for both the auditors and the organizations being audited to exchange information. During this meeting, the audit team leader identifies the scope, plan, and contractual obligations of the audit. The following information is also provided at this meeting: audit goals; meeting facilities availability; interviews to be conducted; specific audit schedule; expected contributions of each participant; and a list of materials, documents, and tools to be examined during the audit process.

Interviews are held by the auditing team to gain knowledge from those individuals responsible for implementing procedures, approving changes or fixes, and keeping project records. The checklist is used to guide the discussions during the interviews. Each interviewee describes the methodologies and techniques used to comply with the processes and procedures being audited. The interview also focuses on indications of deviations or abbreviations to the documented procedures. The team takes this opportunity to clarify any issues that may have resulted from their review of the procedures and processes.

## 6. Audits

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### 6.1 Auditable Areas

The QA Team will implement audits in the following areas. These areas are derived from the Institute of Electrical and Electronics Engineers (IEEE) (730) and the Software Quality Program (DOD-STD-2168), as well as the Performance Assurance Requirements (PAR) document. Some of these areas will be audited in the context of other areas. For example, Metrics will not be a "standalone" audited area. Metrics will, to some extent, be an issue within each audit.

#### 6.1.1 Product Documentation

These audits shall ensure that documents governing the development, verification and validation, use, and maintenance of the product, including requirements traceability, are produced, implemented and maintained.

#### 6.1.2 Software Development Processes

These audits shall ensure compliance to the processes documented in the Software Development Plan, including but not be limited to, Software Release Management, Software Engineering, Software CM, Software Corrective Action, Documentation and Test.

#### 6.1.3 Software Development Library

These audits shall ensure that the library and its operation comply with the contract and adhere to software library practices and procedures. They will ensure that the most recent authorized version of materials under configuration control are clearly identified and are the ones routinely available from the library. These audits will ensure that previous versions of materials under configuration control are clearly identified and controlled to provide an audit trail that permits reconstruction of all changed made to each configuration item.

#### 6.1.4 Non-Development Software

These audits shall ensure that non-development software being incorporated into deliverable software performs required functions prior to its incorporation. They will also ensure that the software was placed under configuration control prior to its incorporation and that data rights and provisions are consistent with the contract.

#### 6.1.5 Deliverable Elements of the Software Engineering and Test Environments

These audits shall ensure that the deliverable elements of the software engineering and test environments comply with the contract and adheres to the software plans. They will ensure that objective evidence exist, prior to its use, that it performs required functions. These audits will ensure that the elements were placed under internal configuration control prior to their use and that data rights and provisions are consistent with the contract.



### **6.1.6 Subcontractor Management**

These audits shall serve to evaluate all subcontractor activity to assure that all subcontractor developed software and related documentation deliverable to the contracting agency satisfies the prime contract requirements. They will ensure that a set of baselined requirements is established and maintained for the software to be developed by the subcontractor. These audits will ensure that applicable software quality programs are included or referenced in the subcontract or purchase documents for the subcontractor.

### **6.1.7 Acceptance Inspection and Preparation for Delivery**

These audits shall ensure that all required software products are available and ready for contracting agency inspection. The audits shall ensure that all required procedures have been performed and evidence is available for contracting agency inspection. Audits shall ensure that all deliverable software and documentation have been updated to reflect all changes approved by the contracting agency and scheduled for inclusion.

### **6.1.8 Standards and Practices**

These audits are conducted to ensure that Documentation, Logic Structure, Coding, Commentary and Testing standards and practices are followed per the identified development standards for the product.

### **6.1.9 Metrics**

These audits are conducted to ensure compliance with the Project Level Metrics Paper and the Quality Office Metrics Project Instruction (PI-QO-1-014).

### **6.1.10 Test**

These audits shall consist of reviewing test monitoring and inspection records as well as verifying test procedures and processes.

### **6.1.11 Risk Management**

These audits are conducted to ensure compliance with the methods and procedures employed to identify, assess, monitor, and control areas of risk on the project.

### **6.1.12 Release Planning Management**

These audits shall evaluate the methods, processes, and procedures employed to release products to the user community for each scheduled release.

### **6.1.13 Procurement**

These audits shall examine the records, procedures and processes for procurement, receiving and inspection, installation and verification, integration and test, and maintenance and operation of hardware.

## 7. Reporting of Audit Results

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### 7.1 Audit Reporting

Once the audit is completed, initial results are shared with the staff of the audited area during a debrief meeting. The meeting provides an opportunity to clear up misunderstandings and allows project staff to present information they feel the auditor failed to consider. In addition, staff members learn immediately about problems and can begin making plans to correct and improve their processes.

After adjusting the initial results to reflect the information gathered in the debriefing, the auditor prepares a written final report, the Internal Audit Report (IAR). The report highlights the most significant issues, addresses both commendations and recommendations, and includes a general narrative of the audit.

This report includes the following sections:

- Audit Identification
- Scope
- Checklist results (Attach checklist)
- Conclusions
- Discrepancies
- QA follow-up activities
- Plans for follow-up audits

This is an internal, comprehensive report of the audit process. It is a formal QA record and will be maintained by the Quality Office. IARs are available for GSFC's review upon request.

### 7.2 Reporting of Results

A documented account of each audit shall be provided for the record and to management of the audited organizations with recommendations for correction of deficiencies in accordance with Audit Reports (DID 506/PA3). The QA Manager tracks and reports resolution of action items and discrepancies through the assigned Quality representatives and ECS project status reviews. The Quality Office provides GSFC with monthly audit report summaries in the Performance Assurance Status Reports (DID 503/PA3).

The QA Manager conducts a post-audit presentation at the ECS Project management reviews. The post audit presentation summarizes the audit findings, deficiencies, and recommendations. Follow-up action items are recorded and tracked by the Quality Office.

### **7.3 Follow-up**

Actions to resolve deficiencies identified in the audit report are taken by the audited area. It is the responsibility of the audited area management to improve on processes in response to deficiencies identified by the audit. These changes and improvements are tracked by the Quality Office to ensure they are documented. The QA and audited area management work together to identify solutions to effectively correct deficiencies noted against standards, procedures and processes as a result of the audit.

Follow-up audits will be conducted in cases where multiple problems with cascading effects are uncovered. The Audit Team Leader identifies such cases in the IAR documentation, and the QA manager schedules the follow-up audits.

# Abbreviations and Acronyms

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CCB	Configuration Control Board
CDRD	Contract Data Requirements Document
CDRL	Contract Data Requirements List
CM	Configuration Management
CSMS	Communications and System Management Segment
DADS	Data Archive and Distribution System
DCN	Document Change Notice
DID	Data Item Description
DMO	Data Management Office
DSN	Deep Space Network
Ecom	EOS Communication
ECS	EOSDIS Core System
EOC	EOS Operations Center
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
ESN	EOSDIS Science Network
FOS	Flight Operations Segment
GSFC	Goddard Space Flight Center
HAIS	Hughes Applied Information System
IAR	Internal Audit Report
ICC	Instrument Control Center
IEEE	Institute of Electrical and Electronics Engineers
IMS	Information Management System
IP	Internet Protocol
IST	Instrument Support Terminal
NASA	National Aeronautics and Space Administration
NSI	NASA Science Internet
PAIP	Performance Assurance Implementation Plan

PAR	Performance Assurance Requirements
PGS	Product Generation System
PI	Project Instruction
PSCN	Program Support Communications Network
QA	Quality Assurance
SCF	Science Computing Facility
SDPS	Science Data Processing Segment
SI&P	System Integration and Planning Office
SMAP	Software Management and Assurance Program
SN	Space Network
V&V	Verification and Validation